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BOTANY.—*A new spiral-orchid from the southern states.*[1] EDGAR T. WHERRY, University of Pennsylvania.

While studying the soil-reaction relations of native plants in the south, I have repeatedly observed in boggy pinelands a spiral-orchid (ladies-tresses) not corresponding to any species included in Small's Flora.[2] It is closely related to the Slender Spiral-orchid [*Ibidium gracile* (Bigel House)], and search for morphological differences between them has not been particularly successful. They are, however, more or less distinct in flower color, sepal length, habitat, range, and blooming period, and show no evident intergradation. The southern plant is accordingly here described as a new species.

Lateral sepals little exceeding the bend in the green-centered lip; growing in moderately acid grassy fields, S. C. to Tex. and northward to N. S. and Man.; blooming in summer.....*Ibidium gracile*

Lateral sepals decidedly exceeding the bend in the yellow-centered lip; growing in strongly acid moist pine-lands, Fla. to Tex. and northward to central S. C.; blooming in spring.....*Ibidium floridanum*

Ibidium floridanum Wherry, sp. nov.

FIG. 1.

I. gracili similis, sed floribus vernalibus et labii medio intense flavo.

Resembling *I. gracile;* roots several; principal leaves basal, appearing in autumn and withering the following summer, more or less petioled, the blades elliptic, 1 to 4 cm. long and 5 to 20 mm. wide; stem 15 to 40 cm. tall, bearing 4 to 7 remote scale-like leaves; raceme 3 to 10 cm. long, single ranked, often strongly spiralled; flowers usually opening in March or April (occasionally as early as mid-December or as late as mid-May); color creamy white with the middle of the lip deep yellow [in this respect resembling *I. plantagineum* (Raf.) House]; lateral sepals about 5 mm. long, often projecting rather markedly beyond the bend in the lip; callosities stubby, 1 mm. long.

[1] Contribution from the Botanical Laboratory of the University of Pennsylvania. Received November 26, 1930.

[2] Flora of the Southeastern United States. 319. 1903.

Type in U. S. National Herbarium, no. 1,466,427, collected by Edgar T. Wherry April 14, 1930, near Loretto, Duval County, Florida. Named from the fact that it is widespread and abundant in this state, specimens having been seen from the following counties: Broward, Duval, Flagler, Gadsden, Hillsborough, Jackson, Lake, Lee, Marion, Orange, Pinellas, St. Johns, and Walton.

Noteworthy specimens are as follows:

FLORIDA:

Tampa Bay, *Burrows*, 1834; the earliest known collection (New York Botanical Garden)

FIG. 1. *Ibidium floridanum*
Type locality. Natural size.

Fort Myers, *Standley*, December 14, 1919; an unusually early blooming date (United States National Herbarium)

Fort Lauderdale to Miami, *Small & Carter*, February, 1911; the southernmost known station (N. Y. B. G.)

GEORGIA:

Milledgeville, *Boykin*, 1836 (N. Y. B. G.).

Wrightsboro, *Chapman* (N. Y. B. G.)

SOUTH CAROLINA: Anderson, *Davis*, April 9, 1919; the northernmost known station (U. S. N. H.)

ALABAMA: Mobile, *Mohr*, May, 1868 (U. S. N. H.)

MISSISSIPPI: Koshtaw, *Tracy*, May 20, 1898. (N. Y. B. G.)

LOUISIANA: Alexandria, *Hale*, April. (N. Y. B. G.)

TEXAS: Houston, *Hall*, April 1, 1872; the westernmost known station (N. Y. B. G.)

The southernmost occurrences of *I. gracile* represented among specimens seen are:

SOUTH CAROLINA: Aiken, *Ravenel*, September, 1869 (U. S. N. H.)
ALABAMA: Auburn, *Pollard & Maxon*, July 9–11, 1900 (U. S. N. H.)
ARKANSAS: Texarkana, *Heller*, August, 1898 (N. Y. B. G.)

The ranges of the two species thus barely overlap.

PALEONTOLOGY.—*Revision of the names of three fossils from the Castle Hayne and Trent marls in North Carolina.*[1] L. B. KELLUM, University of Michigan. (Communicated by C. WYTHE COOKE.)

In Professional Paper 143 of the United States Geological Survey, 1926, the writer described a number of new species of invertebrate fossils from the Castle Hayne and Trent marls of North Carolina. His attention has since been called to the preoccupation of two of the specific names used in that paper, and to an earlier description of a species which he described and named as new. The names incorrectly used in Professional Paper 143 are *Cassidulus berryi* Kellum, applied to an echinoid from the Castle Hayne marl, *Terebratula crassa* Kellum, for a brachiopod from the Trent marl, and *Macrocallista minuscula* Kellum, applied to a mollusk from the Trent marl. New specific names are therefore proposed for the first two of these fossils and an earlier name replaces the third.

Cassidulus (Pygorhynchus) sabistonensis Kellum, nom. nov.

New name for *C. berryi* Kellum, 1926, described and figured in U. S. G. S. Prof. Paper 143: 15, pl. 1, f. 4–7. The specific name *berryi* was used by M. W. TWITCHELL in 1915 for a *Cassidulus* occurring in the Waccamaw marl at Neills Eddy Landing, Cape Fear River, N. C. This was published in U. S. G. S. Monograph 54 on *The Mesozoic and Cenozoic Echinodermata of the United States*. As the name is therefore preoccupied in this genus, I propose the specific name *sabistonensis* for the form collected two miles north of Jacksonville, Onslow County, N. C. on the farm of E. W. SABISTON.

Terebratula posteriora Kellum, nom. nov.

New name for *T. crassa* Kellum 1926. The specific name *crassa* is preoccupied in this genus, having been used by D'ARCHIAC in 1846. The writer's attention was called to this fact by WILLIAM HEALEY DALL in a letter dated October 20, 1926. Dr. DALL says: "Now there is an earlier *Terebratula crassa* of D'Archiac 1846; see Soc. Geol. France mém. 2me ser. 2, p. 318, pl. 18, figs. 8*a-d*, 9—according to CARUS and ENGLEMANN."

As this new species from North Carolina has been found at only one locality and all specimens collected are broken along the anterior margin, the new name *posteriora* is indicative of the part of the shell usually preserved.

Callista (Callista) nuesensis (Harris)

Synonym: Macrocallista minuscula Kellum 1926. This species was described and figured by G. D. HARRIS in 1919 in the Bulletin of American

[1] Received December 17, 1930.

Paleontology vol. 6, No. 31, p. 136, pl. 43, figs. 4–7, 10, as *Meretrix neusensis* In February 1927, KATHERINE VAN WINKLE PALMER in a monographic study of the Veneridae of Eastern America, Vol. 1, No. 5, assigned this species to the genus *Callista*. The specimens figured by these authors are casts of the interior and exterior, except for one pseudomorph. The valve figured by the writer in Prof. Paper 143, pl. 10, figs. 1–2, is an almost perfectly preserved shell.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

236TH MEETING

The 236th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club on Thursday, December 18, 1930. About ninety persons were present. President BOWIE called the meeting to order at 8:15 and introduced the speaker of the evening, Prof. A. M. BANTA of Brown University and Research Associate of the Carnegie Institution.

Program: A. M. BANTA: *What the crustacean tells us about evolution.*— Studies in parthenogenetic inheritance in *Cladocera* have revealed the occurence of certain mutations—some morphological, others physiological in their effects. By means of selection some of these changes have been progressively increased or decreased in accord with the direction sought in selection. Since selection and return selection have been successful in whichever direction attempted, it appears that further genetic changes (new mutations) are occurring. Such derivation of two different and relatively stable types from a single ancestor seems to represent evolution in its simplest form and it is believed that these studies may throw some light upon one of the methods of evolution.

As one of the results of the study of some of the mutant characters in *Daphnia longispina* in sexual reproduction it was found that the characters studied were inherited, as anticipated, in typical mendelian fashion. An unexpected result of the studies in sexual reproduction was the finding of evidence that many physiological mutations occur during parthenogenesis. Further studies on this point have shown that after a long and uninterrupted succession of parthenogenetic generations, numerous lethal, sublethal and other physiological recessive mutations (not present or present in very limited numbers in the early parthenogenetic generations) have accumulated during the long period of parthenogenesis. This was demonstrated by (1) inbreeding among the members of a parthenogenetic pure line or clone early in its parthenogenetic history and (2) again after the lapse of a large number of parthenogenetic generations. Few of these recessive lethal and other physiological characters manifest themselves in the early inbreeding; many manifest their presence in the later inbreeding experiments.

One character, "thermal," which appeared in the inbreeding of a clone long parthenogenetic was of more than usual interest. It is a recessive which presumably occurred as a mutation during parthenogenesis but in simplex or hetorozygous condition and manifested itself only when it became duplex or homozygous in one of the sexually produced offspring derived from inbreeding the clone involved. Individuals of this derived thermal clone were more resistant to high temperatures, less resistant to lower temperatures, had a

higher optimum temperature and in other ways manifested their thermal character as contrasted with individuals of other related but non-thermal clones. Such an origin of thermalness offers the possibility of explanation of the origin of thermal races in nature by mutation rather than by a long period of acclimatization as we have been wont to assume. (*Author's abstract.*)

237TH MEETING

The 237th meeting of the ACADEMY, being the 33rd annual meeting, was held in the Assembly Hall of the Cosmos Club at 8:15, on Thursday, January 15, 1931, with 125 persons present. Vice-President J. M. COOPER called the ACADEMY to order at 8:15 and introduced the retiring President, WILLIAM BOWIE, who addressed the ACADEMY upon, *Shaping the earth.*

At the close of the address the Vice-President announced the annual business meeting and declared a recess, with the request that members of the ACADEMY remain. Then President BOWIE called the meeting to order.

The minutes of the 32nd annual meeting were read by the Recording Secretary and approved. The report of the Corresponding Secretary, L. B. TUCKERMAN, recorded an addition of 31 new members during the year 1930, and the election of Dr. FRANK WIGGLESWORTH CLARK, Dr. WILLIAM H. HOLMES and Dr. LELAND O. HOWARD as honorary members. The members of the ACADEMY stood for a moment in respectful memory of the following members who died during the year:

E. C. CHILCOTT
ASAPH HALL
OLIVER P. HAY
FRANK J. KATZ
LOUIS MACKALL
WILLIAM A. ORTON
DANIEL W. SHEA

The membership was summarized for the year as 18 honorary members, 3 patrons, 1 life member and 560 members. Total membership 582, of whom 381 reside in or near the District of Columbia. The report of the Corresponding Secretary was approved.

The report of the Recording Secretary showed that 8 meetings had been held, of which one was a joint meeting with the Geological Society. Seven of the meetings were devoted to the series of lectures upon *Origin and evolution.* The names of the speakers and titles were given. The minutes of these meetings and abstracts of the addresses given had been prepared for publication in the Journal. The report of the Recording Secretary was ordered accepted.

The Treasurer, H. G. AVERS, reported in full upon the investments, receipts and expenditures of the ACADEMY. The summary showed receipts during the year, $7,805.34. Bank balance January 1, 1930, $2,798.70. Total to be accounted for, $10,604.04. Disbursements, $9,584.35. Bank balance, December 31, 1930, $1,019.47.

FINANCIAL STATEMENT

ASSETS		LIABILITIES	
Cash	$1,019.47	Dues prepaid	$20.00
Investments	21,133.87	Subscriptions prepaid	294.70
Accounts receivable	50.00	Accounts Payable (Estimated)	350.00
Dues unpaid (21)	105.00	Estimated net worth	21,643.64
	$22,308.34		$22,308.34

The report of the Auditors was received and both reports were declared approved.

Professor E. W. WOOLARD, Senior Editor, reported for the JOURNAL of the ACADEMY that volume 20 consists of 520 pages, including 85 half-tones and 47 line-cuts. It contains 56 original papers occupying 418.6 pages and representing 14 different branches of science; the proceedings of the ACADEMY and affiliated societies occupy 74.4 pages; notes and news, and obituaries occupy 19 pages. The total cost of producing and distributing the Journal was $3531.52. The report of the Editor was approved.

An informal report of the Meetings Committee was given by Dr. W. J. HUMPHREYS.

L. V. JUDSON, Chairman of the Board of Tellers, announced the election of the following officers for 1931:

N. A. COBB, President
CYRUS ADLER and W. D. COOLIDGE, Non-resident Vice-Presidents
PAUL E. HOWE, Corresponding Secretary
CHARLES THOM, Recording Secretary
H. G. AVERS, Treasurer.
L. B. TUCKERMAN and N. M. JUDD, Managers for the term of three years ending January, 1934.

The Corresponding Secretary then read the nominations for Vice-Presidents of the ACADEMY as received from the affiliated societies, and the Recording Secretary was authorized to cast one ballot for the ACADEMY, electing the following members as Vice-Presidents:

Anthropological,	Dr. JOHN M. COOPER
Archaeological,	Dr. WALTER HOUGH
Bacteriological,	Dr. L. A. ROGERS
Biological,	Dr. ALEXANDER WETMORE
Botanical,	Dr. H. B. HUMPHREY
Chemical,	Dr. R. E. GIBSON
Electrical Engineers,	Dr. G. W. VINAL
Engineers,	Mr. W. E. PARKER
Entomological,	Dr. HAROLD MORRISON
Foresters,	Dr. F. C. CRAIGHEAD
Geographic,	Dr. F. V. COVILLE
Geological,	Dr. G. R. MANSFIELD
Helminthological,	Dr. PAUL BARTSCH
Historical,	Mr. ALLEN C. CLARK
Mechanical Engineers,	Mr. H. L. WHITTEMORE
Medical,	Dr. HENRY C. MACATEE
Military Engineers,	Colonel C. H. BIRDSEYE
Philosophical,	Dr. H. L. CURTIS

At the close of the business meeting, President BOWIE appointed Past-President W. J. HUMPHREY to escort President-elect N. A. COBB to the Chair. The new President spoke briefly, and there being no further business, declared an adjournment at 10:25.

CHARLES THOM, *Recording Secretary.*

PHILOSOPHICAL SOCIETY

1007TH MEETING

The 1007th meeting was held in the Cosmos Club Auditorium, May 10, 1930, President LAMBERT presiding.

Program: G. H. KEULEGAN: *Measurement of the elastic hysteresis by means of tuning forks.*—The damping of the vibrations of a tuning fork when freely suspended is due mainly to elastic hysteresis, provided that the material of which the fork is made has negligible elastic afterworking. The damping, therefore, can be predicted from pure statical results provided that the statical flexure of the forks differs very little from that realized during the free vibrations. Statical and dynamical data obtained for a U-shaped fork of Armco-iron illustrate this point. This investigation makes it possible to measure elastic hysteresis by means of a freely vibrating fork instead of the tedious, time-consuming and less sensitive statical method. (*Author's abstract.*)

Discussed by Messrs. TUCKERMAN, BROWN, and HAWKESWORTH.

L. V. JUDSON: *New instruments and methods in length measurements of high precision.*—An extensive program of intercomparisons and calibrations of graduated meter and decimeter bars has been carried out at the Bureau of Standards during the past three years using the new high-precision longitudinal comparator made by the Société Genevoise d'Instruments de Physique. The author described the comparator and discussed the measurements made with this instrument. He pointed out that in the case of standards with good surfaces and lines, the residuals generally average less than 0.05 micron, and that the probable errors of the computed values for the differences in length of two standards or for the relative lengths of the subintervals of a standard are rather consistently of the order of 0.02 or 0.03 micron.

The manner by which the corrections to intervals as short as 0.1 mm. are determined using as the basis the U. S. national prototype meter was briefly outlined. Allusion was made to computations, still in progress, to determine the reliability of the several possible methods of obtaining the corrections to the subintervals of a graduated scale.

It was pointed out that the measurement of angles is a natural extension of measurements of length as the same general fundamental principles govern and somewhat similar equipment is used. With the Bureau's one-meter circular dividing engine several circles have been graduated and one 9-inch circle has been tested in some detail using the circle-testing equipment of the Bureau. With this latter instrument consistent and repeated settings and calibrations are possible to 1 second or better, and in the case of the circle just referred to, no errors in the graduation of the circle were found in excess of 2 seconds. It was concluded that these two instruments, both made by the same Swiss firm as the length comparator, are, like that comparator, instruments of high precision. (*Author's abstract.*)

Discussed by Messrs. HEYL, CURTIS, BROMBACHER, and FERNER.

1008TH MEETING

The 1008th meeting was held in the Cosmos Club Auditorium, May 24, 1930, President LAMBERT presiding.

Program: PAUL R. HEYL: *The place of reason in nature.*—Most thinking persons, especially scientific men, hold reason in the highest esteem. There are, however, several schools of thought that regard it differently. These are the philosophy of pessimism, one branch of theology, the pragmatic philosophy of Peirce and William James, and the irrational philosophy of Bergson.

It was pointed out that while reason is undoubtedly equal to all quantitative demands, there may be criticisms of a qualitative nature made against it. (*Author's abstract.*)

1009TH MEETING

The 1009th meeting was held in the Cosmos Club Auditorium, October 11, 1930, President LAMBERT presiding.

Program: M. F. PETERS: *An investigation of the effectiveness and reliability of electric sparks in automotive ignition.*—The effectiveness of ignition sparks was determined by measuring the volume (or mass) of hydrogen and of oxygen which combines at low pressures. The sparks were generated by a magneto and an ignition spark coil. It was found that with constant energy the amount of reaction increases as the capacitance component of the spark increases. The use of a series spark gap may decrease or increase the amount of reaction, the effect depending upon the amount and the distribution of capacitance in the circuit. So far as the work has progressed, it has been found that sparks reported by other investigators as being most efficient for igniting lean mixtures cause the largest amount of reaction. Differences between the amount of reaction with a magneto spark and an ignition spark coil were noted. The method appears to offer a means of determining the most efficient spark generator for internal combustion engines as well as determining a relation between the character of spark, energy and effectiveness in igniting inflammable mixtures.

Further details of this investigation are given in a report which is to be issued as National Advisory Committee for Aeronautics Technical Report No. 369. (*Author's abstract.*)

Discussed by Messrs. HULBURT, WHITE, and SILSBEE.

W. G. BROMBACHER. *Temperature coefficient of the modulus of rigidity of instrument-diaphragm and spring materials.*—In cooperation with the National Advisory Committee, the Bureau of Standards is determining experimentally the temperature coefficient of the elastic moduli of commonly used spring and diaphragm materials in the temperature range $-50°$ to $+50°$ Centigrade. Such data are of particular interest in determining the effect of temperature on the performance of air-craft instruments.

The temperature coefficient m is defined by the relation

$$m = \frac{1}{G_o}\frac{dG}{dT}$$

in which G and G_o are the moduli of rigidity at temperatures T°C. and 0°C.

The description of the apparatus and the methods of procedure were presented for determining this coefficient by means of the torsion pendulum.

Results were given for monel metal, brass, phosphor bronze, coin silver, nickel silver, oil-tempered steel, piano wire, chromium-vanadium steel, chromium-molybdenum steel and a stainless steel and also the effect of heat treatment on the coefficient for a number of the materials.

A full description of the work is given in National Advisory Committee for Aeronautics Technical Report No. 358. (*Author's abstract.*)

Discussed by Messrs. CANFIELD, HUMPHREYS, WHITE, and MEHL.

1010TH MEETING

The 1010th meeting was held in the Cosmos Club Auditorium, October 25, 1930, PRESIDENT LAMBERT presiding.

Program: C. L. GARNER: *An outline of the expanded program of geodetic work of the Coast and Geodetic Survey.*—To explain the future program for geodetic work, it is necessary to review some of the events leading up to the present. In 1925, Congress passed the Temple Act, which authorized the

completion of the topographic map of the United States in a period of twenty years. This Act apparently implied that appropriations would be made from year to year, as required to carry on the work. Topographic maps are a result of cooperative surveys of the Coast and Geodetic Survey and the Geological Survey, the former Bureau performing that part of the work known as control surveys, consisting principally of first-order triangulation and leveling. Up to this fiscal year, there was no increase in the funds annually made available for the Coast and Geodetic Survey, and the Bureau did not take any part in the program, other than to extend such control surveys as its limited funds permitted. The appropriations for the current year carried an increase of some $240,000 for the execution of control surveys as the Coast Survey's initial part of the program for completing the topographic map of the United States. For the most part these control surveys will consist of first-order triangulation and leveling, the triangulation being the means of determining the latitudes and longitudes of marked stations, and the azimuths and distances between them, while the leveling furnishes the elevations of bench marks.

Approximately 27,000 miles of triangulation, measured along the axes of the various schemes, have been completed, and the work under the new program is to divide the open areas by a sufficient number of arcs so that few places in the country will be more than twenty-five miles from a triangulation station. Schemes of first-order triangulation will generally be about one hundred miles apart, while second-order schemes will be run midway between the first-order arcs, thus placing the arcs or bands of triangulation at intervals of about fifty miles. Other arcs of triangulation, at right angles to those described, will be run at intervals of about one hundred miles for the purpose of coordinating the entire scheme in one rigid framework, for purposes of adjustment. This additional work will require about forty thousand miles of triangulation, as measured along the line of progress, consisting of about equal amounts of first- and second-order work.

During the earlier work, arcs of triangulation were extended mostly over mountainous or rolling country where long lines could be used to extend control as rapidly as possible with the cash outlays available. The difficulty of transporting the parties and equipment into isolated sections also contributed toward the same end. As a result long lines over 100 miles in length were very ordinary, while some were in excess of 170 miles. After the Atlantic and Pacific Coasts were connected and there were other arcs sufficient for adjustment purposes, long lines were no longer important. Further than this, with the extension of triangulation into the more settled and developed regions, which are also on comparatively level ground, it is impossible because of the curvature of the earth, and in many places because of tall trees, to secure long lines even though it were desired. Considering the fact that schemes with short lines do not decrease the accuracy of triangulation when extended across country, and to the further fact that short lines have the effect of placing a larger number of stations in any unit area than where long lines are used, the value of the stations to local engineers or surveyors is increased correspondingly. It is difficult and expensive for a local engineer to connect to a triangulation station which is a considerable distance from any particular project he has in mind, while it is comparatively simple and inexpensive to make connections to stations which are nearby. For that reason, the lengths of future lines of first and second order triangulation will be held to an average of between 10 and 12 miles, with few lines exceeding 15 miles in length except in mountainous regions where due to topography and

transportation it may be impracticable to hold to this lower limit. In such cases it may be necessary to allow a few lines with lengths of about 25 miles.

Recent accomplishments of first-order triangulation are the completion of five moderately short arcs during the summer of 1930, as follows: From La Crosse to Fond du Lac, Wis., from Columbus, Nebr., to Joliet, Ill., and three arcs radiating east, north and west from Cairo, Ill., to Nashville, Tenn., to the 39th-parallel triangulation in the vicinity of Belleville, Ill., and to Poplar Bluff, Mo., respectively. Other arcs to be started in the near future and due to be completed by June 30, 1931, are from Fort Smith, Ark., south to Port Arthur, Tex., from Shreveport, La., to Forest, Miss., and from Mobile, Ala., closely paralleling the Gulf Coast, to Corpus Christi, Tex. All of this work is particularly important because of the need for an adjustment of the triangulation network of the United States east of the 98th meridian. An adjustment of the triangulation net of the United States west of the 98th meridian was made in 1927. These two adjustments, when completed, will be based on a large network strong and securely tied together at frequent intervals, and will cover the entire country with the most reliable positions obtainable. These will be held final, and on all future arcs of triangulation it will merely be necessary to adjust them between the junction points with arcs of the above framework.

It should be said that in first-order triangulation average triangle closures of 1 second or less are required, while the maximum allowable closure for a single triangle is 3 seconds. On second-order work the average closure is required to be 3.0 seconds or less, while the maximum closure of a single triangle should not exceed 8.0 seconds. The experience of over one hundred years of observations shows clearly that where maximum single triangle closures are not allowed to exceed 3 seconds, the average closure for a season will very seldom exceed 1.0 seconds, and consequently this criteria is used in classifying the order of triangulation.

In the extension of first-order levels, the same principle holds regarding distribution of marks as with the triangulation stations, that is, for few places in the country to be further than 25 miles from a bench mark. Lines will be run largely along the important lines of communication, such as railroads and highways, in areas which have not been given attention before. Bench marks and triangulation stations are of most value when they are readily accessible at or near the highways, and while it is not practicable to establish all triangulation stations along a railroad or highway, it is entirely possible to so locate the bench marks, and this has been the custom throughout the history of leveling. Incidentally it may be mentioned that formerly the leveling of the country was extended almost wholly along the railroads. This was because of the easy grades encountered and the resultant increased progress and correspondingly reduced cost of the work. As leveling is extended into the intermediate regions, however, it is seen that railroads will, in the majority of cases, not be available, and it will be necessary to extend the lines along highways or even totally unimproved roads. Work of this character is slow and expensive as the grades are much steeper than along railroads, and this requires many more instrument stations and slows up the work. At the same time, the marks are perhaps of more use to the average citizen than in other areas, as in many cases the lines will be along avenues of development where engineering or surveying projects are in operation and where the elevations of the marks will be of immediate use.

Approximately 60,000 miles of first and second order leveling will be required to complete the program. First-order lines will be run at intervals of

about 100 miles, while such intervals will each be divided by one line of second-order levels.

It is believed that this program will be complete in about twelve years. (*Author's abstract.*)

Discussed by Messrs. LIFEROCK, PRIEST, BOWIE, RAPPLEYE, CANFIELD, HUMPHREYS and MARMER.

F. S. BORDEN: *Recent developments in the hydrographic work of the Coast and Geodetic Survey with special reference to the survey of Georges Bank.*

Of the four major classes of transportation, namely: rail, water, highway and air, it can be said that the first mentioned is the only one which has reached real standardization. The highway is making rapid strides in that direction but it will probably be many years before water transportation reaches the high degree of standardization the railroad now enjoys. It will be still longer in the case of the newest means of travel, that by air.

The question may well arise as to why water transportation, one of the earliest methods known to man, has not yet reached the degree of standardization of the railroad and that which we can foresee for the highway. One of the reasons would seem to be that the ocean liner has no well defined path to follow along the shortest practicable route such as has the express train or the automobile. Instead, on each of its journeys a new path must be determined and, under favorable conditions, this is seldom the shortest practicable route and quite frequently not the safest. If an automobilist passes a cross-road onto which he should have turned off, he is only slightly inconvenienced, but should the navigator at some critical point along his route, determine and steer an erroneous course, the result would undoubtedly be disaster with possible loss of life.

The principal aid to the navigator in keeping his vessel on the track which he desires to follow and on one which will avoid the numerous dangers that beset his path, is his chart. The extent to which his chart serves this purpose depends on the detail and accuracy of the information shown thereon and, in this respect, much is demanded by the present-day scientifically equipped navigator.

In order to bring our charts into keeping with the resources of modern science, it has been necessary to devise new and improved methods of surveying those extensive areas which lie out of sight of land but still fall on the shelves which border our coasts. On the Pacific Coast these methods have been well standardized and rapid progress is now being made toward the completion of a new series of standard charts. On the Atlantic Coast the standardization of methods has been somewhat slower, but this process is now reaching the final stage and we can foresee within a few years the same rapid progress that is being made on the Pacific Coast.

I hope to be able with the aid of a few slides to show the reason for the demand for more adequate surveys, and the steps we are taking to meet this demand, some of the difficulties encountered, and finally an outline of the methods actually employed on one of our most recent projects.

Slide No. 1

The old and the new—a month or more to cross the Atlantic as compared with a few days—wooden sailing vessels drawing 15 feet as compared with steam vessels of steel drawing 40 feet. Aids to navigation, very limited, as compared with those of the modern liner having precise sextants, gyro compasses, electric logs, echo soundings, radio bearings and powerful lighthouses. And, in order to obtain the maximum usefulness and the highest degree of security from these present-day resources, the liner *must* have a modern chart.

Slide No. 2

Echo Sounding—Proceeding at full speed, the modern ocean liner has a continuous record of the depths over which it is passing. If the chart shows the configuration of the bottom accurately and in sufficient detail, these records can be used in fixing the position of the ship. On the other hand, if the chart does not portray a true contour map of the ocean bottom, the position of the ship becomes uncertain. This uncertainty means greater precautions, slower voyages, delayed arrivals and increased operating expenses. This new device has had considerable to do with the increased demand not only for more accurate and more detailed surveys but also for the extension farther seaward of such surveys.

Slide No. 3

One type of echo sounding device—the *Fathometer*—and the one used principally on the surveying vessels of the U. S. Coast and Geodetic Survey. This slide shows the recording part of the instrument. Into it comes the impulse of the echo from the ocean bottom transmitted from an oscillator on the vessel. The impulse is received by a hydrophone in the bottom of the vessel and is amplified sufficiently to cause a red flash on the revolving dial, measuring the elapsed time of sound travel to and from the ocean floor, but calibrated to read the depth directly in fathoms. The dial of this particular instrument revolves at a speed of 246 revolutions per minute corresponding to a velocity of sound of 820 fathoms (4920 feet).

Slide No. 4

The velocity of sound in salt water varies over an extreme range of from about 790 fathoms to about 870 fathoms per second depending on the temperature, salinity and pressure of the water through which the sound travels. Roughly, it may be stated that the velocity increases 0.2 of one per cent for every increase of 1° in the temperature, is augmented 0.11 per cent for every 100 meter depth and increases 0.1 per cent for every 1 per cent increase in the salinity. On any surveying project, sufficient measurements are made of the salinity and temperature at various depths to correct the echo soundings.

Slide No. 5

Comparison between the frequency and speed of echo and hand-lead soundings.

Slide No. 6

Installation on the Lydonia—The Fathometer there provides both the navigator and the hydrographer with an excellent method of obtaining depth, but the concern of the hydrographer does not stop here. For every practical purpose, a charted sounding must be considered as having three dimensions. A measurement of depth is of value not simply in proportion to the accuracy with which it was made, but equally in proportion to the accuracy with which we locate the point on the ocean's surface from which it was made. A group of accurate soundings plotted on the chart in their correct positions relative to each other will give an accurate indication of a submarine valley or any other characteristic feature suitable for use by the navigator in fixing his position. The same soundings incorrectly placed with reference to one another may give a seriously erroneous picture. Let us consider that the depth determination furnishes us with the first dimension of our sounding and

turn to the second and third dimensions, it being assumed that we are out of sight of land and can not depend on shore objects to fix the sounding vessel's position.

Slide No. 7

Again we make use of the transmission of sound through water, in this case horizontally. Here we have a depth bomb of TNT fired from astern of the vessel. The sound travels to a hydrophone planted near the shore, the position of which is accurately known. Here the impulse is picked up and amplified and automatically and instantaneously passes through the shore station back to the vessel by radio. The time interval, as recorded on the tape of the sounding vessel's chronograph, between the reception of the bomb and the returning signal from the shore station plus the time it has taken the sound to travel from the bomb to the ship's hydrophone gives a measure of the distance between the bomb and the shore station hydrophone—and we have our second dimension of the sounding taken at the time the bomb was dropped.

Slide No. 8

And adding a second shore station to our equipment, we, in the same way, obtain the third dimension of our sounding.

Slide No. 9

Shore Station on the Pacific Coast—Unfortunately we can not boast of any such shore stations on the Atlantic Coast or that we have thus far been able to employ the exact methods of obtaining the second and third dimension that work so successfully on the Pacific Coast and in Alaska. However, we learned very definitely during the past summer that the method can be used, at least off the New England Coast, provided floating stations are substituted for the shore stations and are anchored in sufficient depths of water. The slides from now on, in so far as the hydrophone station is concerned, pertain to a floating station rather than to a shore station as shown here.

Slides Nos. 10–27

Georges Bank Project—Showing methods employed in the survey of Georges Bank and a slide of the submarine valley found along its southeastern edge. The valley is 2 miles wide and cuts back into the shelf for a distance of 8 miles. It makes an ideal submarine landmark for westbound transatlantic steamers approaching Georges Bank. (*Author's abstract.*)

Discussed by Messrs. HECK, CANFIELD, CURTIS, DORSEY, HAZARD, and SERAN.

OSCAR S. ADAMS, *Recording Secretary*

SCIENTIFIC NOTES AND NEWS

Dr. DAVID WHITE, senior geologist of the Geological Survey and home secretary of the National Academy of Sciences, was awarded the Penrose Medal of the Society of Economic Geologists at the Toronto meeting in December, 1930. This medal is given not oftener than once every three years "in recognition of unusually original work in the earth sciences."

Miss FRANCES DENSMORE, Bureau of Ethnology, who has been in Washington for a few weeks, has left for Florida to study the music and songs of the Seminole Indians.

Dr. NORMAN L. BOWEN of the Geophysical Laboratory has been awarded the Bigsby medal of the Geological Society (London) in recognition of the value of his study of the physical chemistry of igneous rocks. The last recipient of the medal in the United States was the late CHARLES D. WALCOTT who was awarded it in 1895.